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INTEGRATION OF MODELS FOR UNDERSTANDING CONTINUANCE OF PROCESS MODELING TECHNIQUES

Jan Recker
Queensland University of Technology
126 Margaret Street, Brisbane QLD 4000, Australia
j.recker@qut.edu.au

Michael Rosemann
Queensland University of Technology
126 Margaret Street, Brisbane QLD 4000, Australia
m.rosemann@qut.edu.au

Abstract

Process modeling has become an essential aspect of information systems (IS) practice. In line with the increased popularity, a plethora of process modeling techniques has been proposed over time. Yet, despite the proliferation of techniques, only a few have been widely accepted by practitioner communities. However, the long-term viability of a process modeling technique and its eventual success depend on its extensive and continued use by process modelers. While IS researchers have extensively studied the continued acceptance of information systems artifacts, to date, only little research exists that has investigated the issue of process modeling technique continuance.

This paper addresses the problem of process modeling technique continuance by identifying from prior research factors that influence the formation of an intention to continue using a process modeling technique and by performing a theoretical integration of appropriate theories of post-adoption behavioral intention. The resulting research model provides an in-depth understanding of a process modeler's continuance intention.

Keywords: Technology Acceptance, Expectation-Confirmation, Task-Technology Fit, Process Modeling

Introduction

Conceptual modeling is an essential part of information systems analysis and design (Karimi 1988), and can be described as the process of developing a graphical representation of selected phenomena in a domain of interest with the aim of documenting domain requirements to enhance communication amongst relevant stakeholders (Siau 2004). Conceptual modeling of business processes (i.e., process modeling) has become one of most popular reasons to do conceptual modeling overall (Davies et al. 2006). Overall, an increasing demand for a more disciplined approach towards Business Process Management (BPM) has been reported (Gartner Group 2007), which in turn has triggered related academic and commercial work aiming towards, inter alia, advanced business process modeling solutions. Correspondingly, over time, a wide selection of process modeling techniques has been designed, ranging from simple flowcharts and typical business modeling techniques to advanced variants of Petri nets with high expressive power.

Despite the proliferation of process modeling techniques, however, only a few have been widely accepted by the BPM community. IS research has shown that process modeling techniques differ quite significantly in their representational capabilities (Rosemann et al. 2006) or in their support for expressing certain workflow patterns (van der Aalst et al. 2003). Actual practice, on the other hand, informs us that certain process modeling techniques have achieved high levels of adoption and dissemination in modeling practice, e.g., Event-driven Process Chains (EPCs) (Keller et al. 1992) or BPMN (BPMI.org and OMG 2006), while others reside as an object predominantly of interest to academic scholars, e.g., Workflow Nets (van der Aalst 1998). EPCs are a graphical technique used primarily for business modeling purposes while BPMN is a technique based on flowcharts that is used to specify processes to be enacted by means of web service technology. Some recent empirical studies exist that investigate strengths and weaknesses of specific techniques, most notably of EPCs (e.g., Green and Rosemann 2001) and BPMN (e.g., Recker et al. 2006) for process modeling, however, these studies have yet failed to link their findings to actual usage, success and/or acceptance patterns.

In fact, the question of *user acceptance* of process modeling techniques has raised surprisingly few interest amongst IS researchers. Acceptance and usage studies are quite popular in IS research in general (Davis 1989; Goodhue and Thompson 1995; Bhattacherjee 2001) and have also been studied in scenarios of object-oriented modeling methods for IS development (Tan and Siau 2006), but the question of the *continuance decision*, viz., the decision of an individual to continue using an artifact (Bhattacherjee 2001), has not at all been addressed in the process modeling community.

Accordingly, to move forward the research and practice in this area, we examine this phenomenon from a behavioral perspective in order to be able to develop an understanding of the beliefs and attitude towards a process modeling technique that mediate the decision towards continued use (or "continuance").

Accordingly, the *imperative of this research* is to develop an understanding of the continued use of process modeling techniques by individual process modelers. This study focuses on the reasons why individual process modelers are willing to continue using a process modeling technique after its initial adoption. The specific *aim of this paper* is to identify relevant concepts and theories from the literature that can be used to provide a theoretical explanation of the variables and factors that affect the individual modelers' continuance decision.

We proceed as follows. In the next section, we elicit characteristics of process modeling techniques and the process modeling domain in general in order to outline domain-specific factors that potentially pose relevance to the continuance decision. Next, we recapitulate existing theories of IS acceptance, continuance and usage and discuss their applicability to the process modeling domain. We then integrate relevant concepts and theories in a conceptual model of the continuance decision in process modeling. We conclude this paper with a summary of contributions and an outlook to further research.

Background

Success, acceptance and usage in general and in the context of process modeling

Studies on the success of IS artifacts are one of our core research directions. Success as a consequential variable of interest embraces different dimensions, notions and measures. In fact, there are nearly as many measures for success as there are studies (DeLone and McLean 1992). Reported measures include the notions of accuracy (Shannon 2001), influence (Mason 1978), or impact and user satisfaction (Grover et al. 1996). Aside from these notions, one of the most frequently reported measures for success is usage (DeLone and McLean 1992). The importance of the usage measure in the context of IS success stems from the fact that only when an IS artifact is utilized on a prolonged basis by its intended users it releases its potential to generate benefits, influence or impact (Agarwal and Karahanna 2000). Yet, Seddon (1997) raised doubts about the appropriateness of the usage construct as a measure of success. Hence, it appears that deeper insights are needed into what exactly determines usage, and ultimately success, of an artifact. In this context it is often noted that it is foremost the question of the *acceptance*, and not so much potential superior capabilities, of an IS artifact that determines the realization of its benefits (Davis 1989). Potential performance gains that may stem from the prolonged use of an IS artifact are often obstructed by users' unwillingness to accept and use the available artifact (Young 1984). Because of the persistence and importance of this phenomenon, *user acceptance* has traditionally been a key issue (and key measure) in IS success research (Robey 1979; Swanson 1987).

This insight holds true even more so in the area of modeling for IS analysis and domain. Despite the proliferation of arbitrary approaches to modeling overall and to process modeling in particular (Olle et al. 1986), and despite the observable differences between available techniques in terms of their representational capabilities (Rosemann et al. 2006), correctness and ease of use (Batra et al. 1990), or support for domain comprehension and problem solving tasks (Agarwal et al. 1996), only few have been widely accepted by practitioner communities.

This raises the question of how we can explain the diversity in acceptance rates of process modeling techniques and, more precisely, which factors influence the decision to accept a technique and to continue to use it in the post-adoption phase.

The initial adoption of a process modeling technique is often an organizational decision. This holds not only for process modeling domains but for conceptual modeling in general. Ultimately, however, individual modelers are the ones who use a technique and evaluate its acceptability (Ambler 2004). Prior studies, e.g., (Orlikowski 1993; Brown et al. 2002) have suggested that individual modelers do in fact sometimes decide not to use a modeling method even if there has been an organizational decision to adopt it. As Tan and Siau (2006) note, if it were mandatory for individuals to use a modeling technique that they are unwilling to use, their work morale would be worsened, which in turn would negatively impact on their productivity (Frey 1993). Therefore, it is imperative to develop a comprehensive appreciation of the continuance decision in order to be able to develop an informed opinion about the long-term viability and eventual success of a process modeling technique. Along similar lines, Jasperson et al. (2005) suggest in their study that more research focus should be placed on the phenomenon of *post-adoption usage behavior*. They further advise that it is necessary to study how the features of a system or artifact under observation influence or determine usage behavior and intentions. Their conceptualization that includes a feature-centric view of technology has been a motivation for us to develop a theoretical perspective of how features of process modeling techniques, e.g., their representational capabilities (Rosemann et al. 2006), influence and determine how modelers perceive and use the technique. We will address this point further in section four.

Process modeling

Traditionally, the modeling of information systems has focused on analyzing data flows and transformations. This modeling accounted only for the organization's data and that portion of its processes that interacted with data. Newer uses of information systems extend deployment beyond transaction processing into communication and coordination, viz., a process-aware perspective on information systems (Dumas et al. 2005). Process modeling is an approach for visually describing how businesses conduct their operations: A process model is typically a graphical depiction of at least the activities, events/states, and control flow logic that constitute a business process (Curtis et al. 1992). It is widely used within organizations as a method to increase awareness and knowledge of business processes, and to deconstruct organizational complexity. Many studies have shown the relevance of process modeling to BPM initiatives, e.g., (Davenport 1993). The recent introduction of legislative frameworks such as the Sarbanes-Oxley Act (Nielsen and Main 2004) further contributed to the increasing interest in business process modeling as a way of capturing the processes of an organization or information system.

In essence, the application scenarios of process models can be summarized in two main purposes. First, intuitive business process models are used for scoping the project, and capturing and discussing business requirements and process improvement initiatives with subject matter experts and relevant stakeholders. A prominent example of a business modeling technique used for such purposes is the Event-driven Process Chain (EPC). Second, business process models may also be used for process automation, which requires their conversion into executable workflow specifications. Techniques used for depicting process models for this purpose have higher requirements in terms of expressive power. Examples include, for instance, the range of Petri net-based modeling techniques.

The question of purpose is of relevance when deciding to adopt and/or to continue to use a process modeling technique. Many scholarly papers neglect the differences between the use of process models for graphically describing business processes and for formally specifying executable workflows (Dehnert and van der Aalst 2004). In practice, however, this difference is highly relevant as the purpose of process modeling determines the requirements towards a process model, the relevant stakeholders and thus ultimately the technique that is used to build the models. The two introduced main purposes of process modeling each postulate distinct requirements (see Table 1). There are many more distinctions that can be drawn and which show how diverse the range of application scenarios is in process modeling, which in turn separates this modeling discipline from others. For instance, more descriptive applications of process modeling sometimes induce a need to extend process models with further graphical elements to accommodate emerging requirements, such as, for instance, risk modeling (Rosemann and zur Muehlen 2005) whereas the specification of workflows is usually restricted to a limited scope of modeling elements that purely focus data, resource and control flow perspectives. In terms of relevant stakeholders, describing business process models often target a wide audience with high domain knowledge and mostly modest methodological know-how whereas workflow-specifying process models usually target a narrow audience with high methodological knowledge but rather modest domain know-how.

Table 1. Purposes of process modeling and corresponding requirements. Based on (Dehnert and van der Aalst 2004)

Describing business processes	**Specifying workflows**
Provide a basis for communication	Serve as input to process information systems
Must be understandable	Must be machine-readable
Should be intuitive	Should be unambiguous
Should leave room for interpretation	Should not contain any uncertainties

What can be observed from this brief discussion is the critical role of the *types of stakeholders* involved in the modeling process. Accordingly, and not surprisingly, it is often witnessed in process modeling practice that individuals from very different backgrounds perform these different process modeling tasks (e.g., business analysts versus workflow analysts). These individuals possess quite divergent skills and knowledge, a fact that has been discussed in IS research under the notion of domain knowledge (Khatri et al. 2006). Related studies have found that domain knowledge determines the way of thinking, approaching and using means, such as developing and using graphical models, for problem solving and other tasks (McPeck 1990). Given the observable connection between the tasks for which process modeling is being applied and the matching or non-matching skills and knowledge of the involved stakeholders, it is surprising to see that this area has so far not at all been investigated in IS research.

Indeed, while some theoretical reference frames exist to assist in the analytical evaluation of the strengths and weaknesses of process modeling techniques, e.g., (Green and Rosemann 2000; van der Aalst et al. 2003), there is a noted shortage of empirical studies that investigate whether the identified theoretical (i.e., potential) deficiencies, issues, weaknesses or problems with a certain process modeling techniques *in fact* denote critical issues in the actual use of the technique or whether they remain as scholarly stimulating issues without much consequences to process modeling practice. Notable exceptions from this overall gap of knowledge include the studies by Green and Rosemann (2001) and Recker et al. (2006), respectively. In summation, the lack of success and acceptance studies in the area of process modeling has motivated our research on the process modeling technique continuance intention.

Relevant Theories and Concepts

In this section, we present three complementary theoretical perspectives on the acceptance and continuance decision in the IS discipline. These theories will later form the basis for our theoretical model of process modeling technique continuance. In presenting the three perspectives, we have focused on theories that use beliefs towards intrinsic characteristics of an artifact to determine the formation of an intention to continue to use the artifact (technology acceptance model), theories that explain post-adoption behavior with respect to its match with pre-adoption beliefs and expectations (expectation-confirmation theory) and theories that investigate the match between characteristics of artifact, task and user to explain the continuance decision (task-technology-fit).

Technology Acceptance Model

The Technology Acceptance Model (TAM) (Davis 1989; Davis et al. 1989) is an immensely popular IS theory that describes how users come to accept and use an IS artifact on a prolonged basis. The model suggests that when users are presented with an IS artifact two primary factors influence their decision about how and when they will use it. *Perceived usefulness* (PU) is the degree to which a person believes that using a particular artifact would enhance his or her job performance while *perceived ease of use* (PEOU) constitutes the degree to which a person believes that using a particular artifact would be free from effort.

Related studies have found that PU and PEOU directly influence an individual's intention to (continue to) use an IS artifact (Davis 1989; Davis et al. 1989). Also, PEOU was found to be a causal antecedent of PU (Venkatesh and Davis 1996). Figure 1 gives the basic premise of the technology acceptance model.[1]

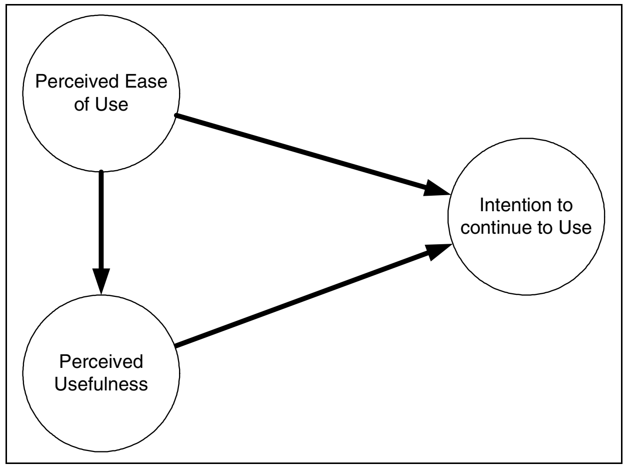

Figure 1. Technology acceptance model (Davis 1989; Davis et al. 1989)

TAM has been identified as a very commonly employed theoretical framework for studying IS acceptance (Lee et al. 2003). In fact, the extensive amount of research related to TAM has reportedly made it one of the most influential IS theories overall. King and He (2006) found in their meta-analysis of TAM that, despite of its recent extensions, for example, the TAM2 model (Venkatesh and Davis 2000), and revisions, for example, the UTAUT model (Venkatesh et al. 2003), primarily the classical model is of high reliability and explanatory power and obtains high levels of robustness. As such, we deem TAM in its original form a suitable starting point for our line of investigation. Its main premise, namely users will choose to accept an IS artifact if it proves to be useful and easy to use, has been shown to hold in a variety of contexts, such as for different systems (for example, email, GSS), in different situations (for example, culture, over time), with different moderating variables (for example, gender, organizational size) and with different subjects (for example, students, knowledge workers, managers). We would expect the same relationships to hold for process modeling domains also.

Expectation-Confirmation Theory

TAM is, in its essence, a theoretical and cross-sectional model that predicts IS acceptance based on user perceptions. However, post-adoption behavior that arises out of users' direct first-hand experience with the target IS, are not explicitly included in TAM. Expectations-confirmation theory (ECT), on the other hand, presents a different yet complimentary perspective on IS continuance (Bhattacherjee 2001). ECT posits that initial pre-usage expectations, coupled with perceived performance, lead to post-adoption satisfaction, which in turn determines the formation of the intent to continue using the artifact under observation. This effect is mediated through positive or negative confirmation between the expectations and the perceived performance. If an artifact outperforms expectations (positive confirmation) post-adoption satisfaction will result. If an artifact falls short of expectations (negative confirmation) the user is likely to be dissatisfied (Oliver 1980).

Expectations reflect anticipated behavior (Churchill Jr. and Surprenant 1982). In a post-adoption setting, the concept of initial expectations bears little merit to a study since pre-usage expectations are typically based on others' opinions or information disseminated through mass media (Bhattacherjee 2001). What is more of interest to a study of post-adoption behavior is whether the initial expectations are confirmed and whether they lead to satisfaction. Perceived performance is often conceptualized as individual beliefs about the use of the artifact (Bhattacherjee 2001). As a meta analysis of TAM studies (King and He 2006) shows, perceived usefulness is the only salient belief that has consistently been demonstrated to

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[1] It should be noted that some related studies have found the support for the relationship between PEOU and PU to be inconsistent and sometimes of less significance. An explanation for this is speculated to reside in the fact that prolonged exposure to an IS artifact remedies potential concerns about the ease of its use (Chau 1996).

influence user intentions across several stages of IS use, perceived performance in the original ECT has in the IS context repeatedly been conceptualized as PU (Bhattacherjee 2001). Figure 2 gives the main premise of ECT in the IS context.

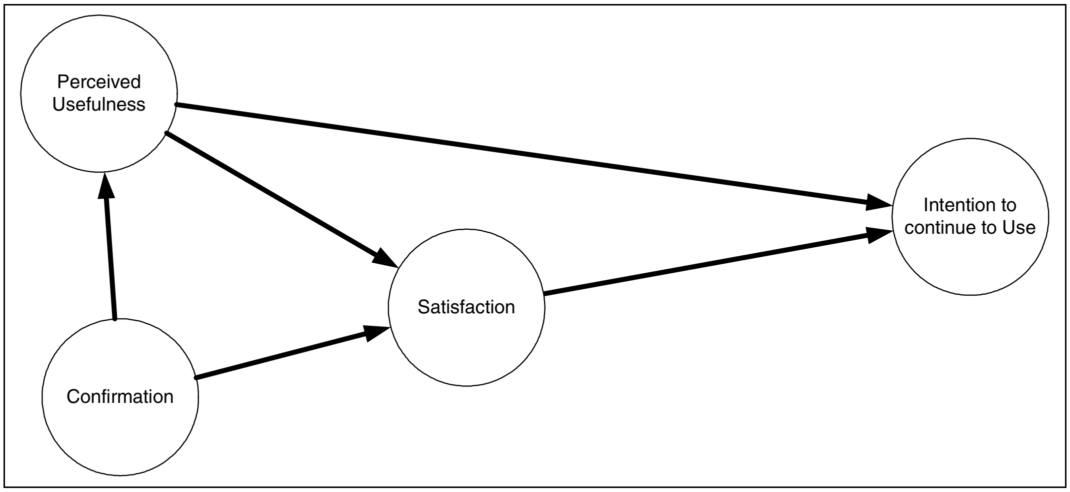

Figure 2. Expectation-confirmation theory (Bhattacherjee 2001; Bhattacherjee and Premkumar 2004)

We argue that adding the ECT perspective to the TAM perspective on process modeling technique continuance allows us to widen the explanatory power of the model over and above usage beliefs to also include external factors such as pre-usage expectations. As organizations traditionally exhibit a great deal of control over pre-usage conditions in process modeling (for instance, the initial selection of a technique, its market penetration, communication through social channels, facilitating resources such as tool support and training capacities), we argue that it is essential to develop an understanding of how the confirmation or disconfirmation of such expectations towards a process modeling technique (that were formed based upon, for instance, facilitating institutional factors) would lead to a satisfying use of the technique and how satisfaction in turn would affect the continuance decision. As a practical rationale for the inclusion of ECT concepts consider the example of the recently proposed BPMN process modeling technique (BPMI.org and OMG 2006). The extensive amount of media announcement, the related standardization processes and the enormous vendor support have motivated a significant number of organizations to rapidly adopt their modeling environments to incorporate BPMN (Recker et al. 2006). This phenomenon can in theory be described as the building of expectations in pre-usage phases since, at that time, no reported studies on the usability or suitability of BPMN for process modeling were available.

Task-Technology-Fit

In the background section on process modeling we elaborated on the multi-facetted nature of process modeling tasks, purposes and skills (e.g., business versus workflow orientation). Clearly, it is to be expected that how well a process modeling technique supports given process modeling objectives *and* the background skills as well as knowledge of the modeler using the technique would have an impact on his/her evaluation of the technique.

The task-technology fit (TTF) theory holds that IS are more likely to have a positive impact on individual performance and be used if the capabilities of the IS match the tasks requirements that the user must perform as well as the user's individual abilities. Goodhue and Thompson (1995) found TTF to be a significant predictor of user evaluations of the IS under investigation, which in turn positively affects perceived performance.[2] Perceived performance, in line with our arguments above, can be conceptualized as perceived usefulness. Figure 3 gives the premise of TTF.

[2] Note here that TTF is usually not explicitly measured but rather the effect of the combination of its components on consequential variables (Goodhue and Thompson 1995). This is indicated in Figure 3 by the dashed lines.

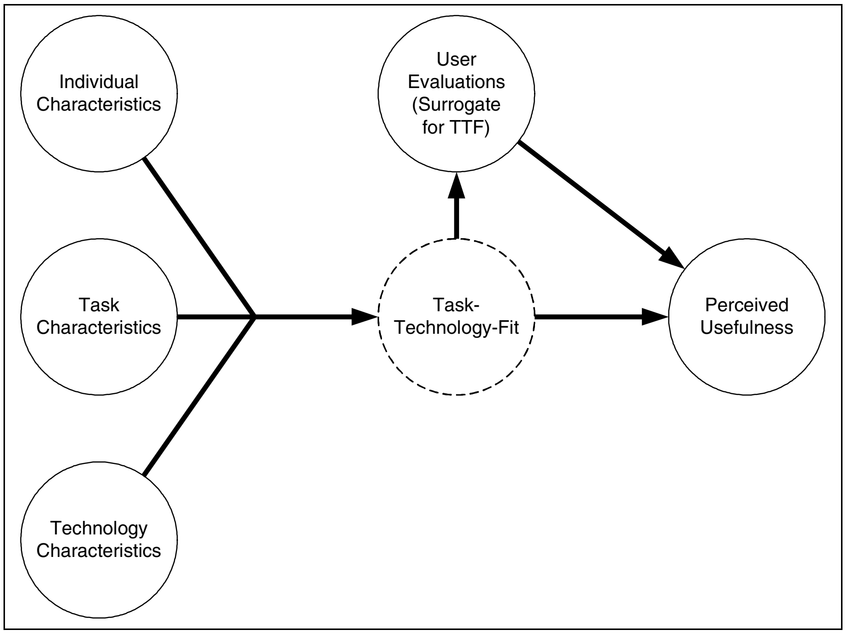

Figure 3. Task-technology-fit (Goodhue et al. 2000)

In the context of process modeling technique continuance we argue that TTF presents a powerful explanatory basis to describe antecedents of post-adoption behavior, which thereby adds another perspective to the models of TAM and ECT, both of which focus *consequential* variables of continuance behavior but do not explicitly consider *antecedents* of such behavior.

Process modeling practice suggests that the different capabilities of process modeling technique serve different process modeling tasks and different users to differing extents. Event-driven Process Chains (Keller et al. 1992), for instance, are widespread in business communities for scoping process improvement projects but have widely been criticized in technical communities for lacking support for depicting workflow requirements (van der Aalst 1999).

Before the background of these observations we put forward three arguments:

1. Process modeling techniques exhibit different *capabilities*, for instance, in their support for workflow patterns (van der Aalst et al. 2003) or in their representation fidelity (Rosemann et al. 2006). Clearly, there are sometimes quite significant differences in the capacities that a process modeling technique offers to its user and to the task with which the modeler is confronted.
2. Similarly, the modelers differ sometimes quite significantly in their skills and *abilities*, for instance, with respect to their cognitive skills (Vessey and Conger 1994), their modeling experience (Shanks 1997) or their background domain knowledge (Khatri et al. 2006). Clearly, the extent to which users of a process modeling technique bring to bear different levels of background knowledge affects the way process models are created with a technique, and correspondingly, the user evaluation of the technique under investigation.
3. Process modeling can serve many purposes and is used in a variety of contexts. Singling out the distinction between business- and workflow-oriented purposes alone (and there are many more, e.g., activity-based costing, process improvement, reference modeling, simulation or knowledge management, to name just a few) indicates how different the *requirements* towards a process model may be.

Forthcoming from these observations we argue that it is not so much the fact that some techniques may have "better" inherent capabilities, or features (Jasperson et al. 2005), for process modeling than others, but rather the extent to which the features or characteristics of a process modeling technique match given skills and tasks, that determine whether or not a modeling individual decides to continue to us it. In light of TTF theory we hence to propose to consider the ternary relation *user abilities-technique capabilities-task requirements* (or simply task-user-technique fit) as an antecedent construct in a model of process modeling technique continuance.

A Theoretical Model of Process Modeling Technique Continuance

Having introduced three theoretical perspectives upon the continuance decision, in the following we discuss how the prolonged acceptance of process modeling techniques can be conceptualized through the integration of these theories whilst taking into account the particularities of the process modeling domain. Figure 4 gives the identified model of process modeling technique continuance, the components of which are discussed below. Compared to the conceptualization of post-adoption usage behavior suggested by Jasperson et al. (2005), our model incorporates their elements 'prior use' (through individual characteristics such as modeling experience, see below) and 'feature-centric view of technology' (through technique characteristics, e.g., the technique capacity to facilitate faithful models of real-world domains, see below).

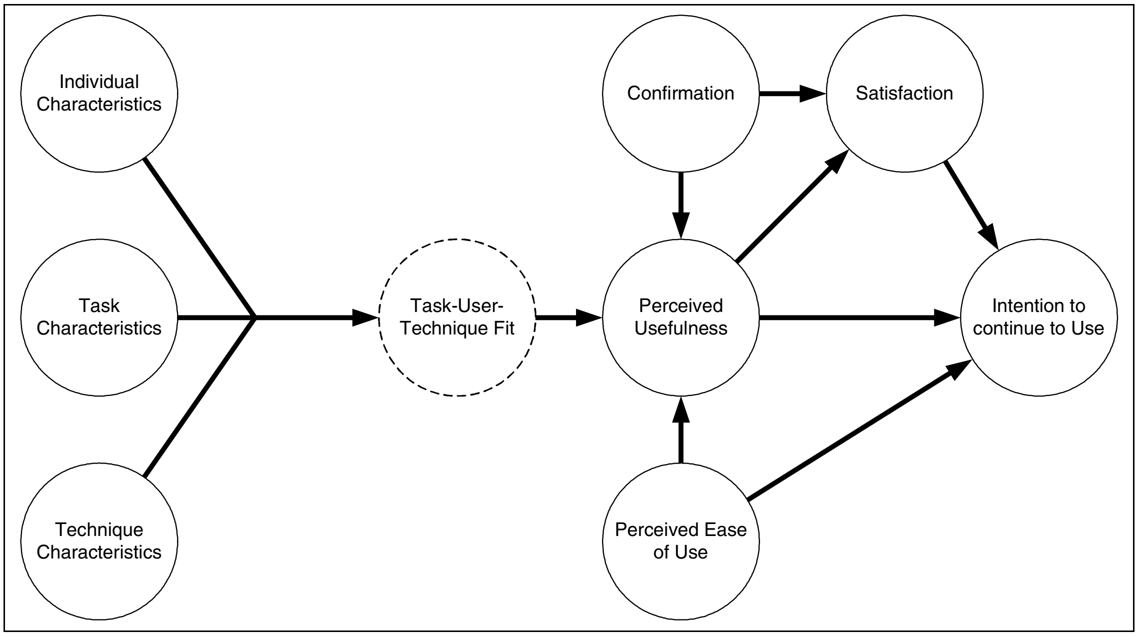

Figure 4. A theoretical model of process modeling technique continuance

Forthcoming from Figure 4 we posit that the formation of the intent to continue using a process modeling technique is primarily dependent on three different factors:

1. whether users form a positive belief about the actual use of the technique, viz., whether they find it useful and easy to use in actual process modeling practice,
2. whether users are able to confirm (or disconfirm) initial expectations from the pre-usage phase about the technique, and
3. whether users feel that the capabilities of the technique match both the task requirements and their own abilities.

More specifically, following the results of (Premkumar and Bhattacherjee in press) we expect that satisfaction, ease of use and usefulness are direct determinants of continuance. The satisfaction construct yields the potential to capture attitudes and beliefs about a technique that stretch both usage patterns (e.g., the perceived usefulness) and pre-usage patterns (e.g., whether or not externally or institutionally driven expectations are confirmed). PU, as the most consistent salient belief about usage in IS acceptance studies yields the capacity to capture performance beliefs (e.g., whether or not using a technique actually improves the quality of the process models or the overall success of the process modeling initiative, or exhibits effectiveness and efficiency gains).

As antecedents of these consequential variables we argue that it is the extent to which the inherent characteristics of a technique match skills and tasks that determines user evaluations and ultimately continuance intentions. Our adaptation of TTF presents a strong theoretical framework for the match between individual abilities, task requirements and technique characteristics. Measures for each of these constructs can hereby be obtained from related work. As indicated before, a number of researchers (e.g., Green and Rosemann 2000; van der Aalst et al. 2003) have established differences between process modeling techniques that could be used as indicators for technique characteristics. Table 1 gives different task requirements pertaining to different process modeling purposes (Dehnert and van der Aalst 2004). Other research has investigated differences in modeler abilities such as domain knowledge (Khatri et al. 2006), modeling experience (Shanks 1997) or cognitive skills (Vessey and Conger 1994), to name just a few factors that could potentially pose consequences.

Contributions and Conclusions

In this paper, we have described and discussed the theoretical conceptualization of a model to explain process modeling technique continuance. The model has been established by integrating components from TAM, ECT and TTF. The rationale for integration as well as the individual constructs has been discussed before the background of the process modeling domain. From a theoretical perspective, this study forms a cornerstone on which knowledge of modeling technique continuance can be established. First, by integrating prominent theoretical perspectives in one model of continuance, we have made a significant step toward a more comprehensive understanding of the complexity that relates to practitioner's intention to continuously use a process modeling technique. Second, we have adopted the general framework of task-technology-fit to the process modeling domain in order to be able to account for specific antecedent factors that display pertinence to process modeling domains and which indirectly affect intention. This adoption of TTF provides a rich framework that may also be used in other related studies to develop a greater and deeper understanding of why individual process modelers use, and form an opinion about, the usage of a process modeling techniques in a variety of settings. Third, we have aimed to incorporate several of the suggestions raised by Jasperson et al. (2005) in order to specify a model that addresses components of post-adoptive behavior that have so far attracted only little attention in IS research.

Our conceptual study suffers from an obvious limitation in being theoretical research. As such, our model can only be an a priori model given the absence of empirical validation. Accordingly, we have started data collection to empirically test our model through a cross-sectional survey research, which is traditionally a typical method for testing models in IS (Grover et al. 1993; Pinsonneault and Kraemer 1993). The population of interest for this study includes process modelers who have knowledge of certain process modeling techniques, viz., EPCs and BPMN. We have developed scales to measure our latent constructs (Recker and Rosemann 2007). Due to the space constraints for conference papers, details of the empirical study are not reported in this paper but will be given in the paper presentation.

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